EAST Browser - L2: (9) 1 near5 mask$ | US 5111286 A | Tag: S | Doc: 8/9 (SORTED) | Format : KWIC

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DETX(9)

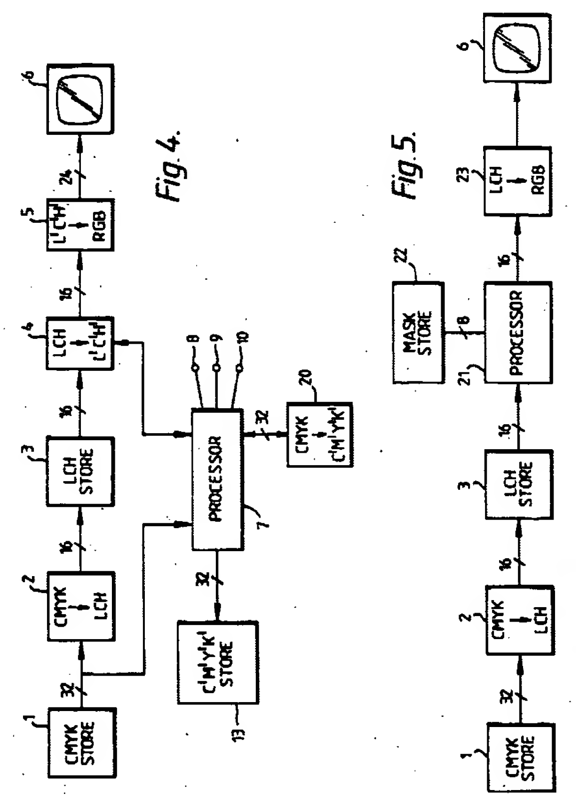

image pixel and
will then be used in a
subsequent processing operation
for example to combine
the image in the store 1 with
another image. In this example,
the image in the
store 1 is fed via the LUT 2 to
a store 3 as before. A
processor 21 then
accesses each pixel value in
turn from the store 3 and
applies this to a
predetermined algorithm. In a
simple case, the algorithm
comprises a
thresholding process in which
the pixel value is compared with
the threshold.
If a pixel value exceeds the
threshold then a control value
"1" is generated
while otherwise a control value
"0" is generated. These values
are then stored
in a mask store 22. This will
generate a so-called "hard" mask
which can
subsequently be used in a
conventional manner. In a more
sophisticated process
the processor may apply an
algorithm for generating a
colour selective mask in
which, for example, the pixel
value accessed from the store 3
is compared with
a target value and depending
upon the difference between the
two, a suitable
control value in the range 0-255
is generated (a "soft" mask).

EAST Browser - L2: (9) 1 near5 mask$ | US 5363146 A | Tag: S | Doc: 7/9 (SORTED) | Format : KWIC

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US005363146A

United States Patent [19]

Saunders et al.

[11] Patent Number: 5,363,146

[45] Date of Patent: Nov. 8, 1994

[54] MOTION COMPENSATED IMAGE PROCESSING

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[21] Appl. No.: 18,416

[22] Filed: Feb. 17, 1993

[30] Foreign Application Priority Data

Mar. 2, 1992 [GB] United Kingdom 9204504

[51] Int. Cl.[5] H04N 7/137

[52] U.S. Cl. 348/699; 348/443

[58] Field of Search 358/105, 136; 348/443, 348/699; H04N 7/137

[56] References Cited

U.S. PATENT DOCUMENTS

4,862,267 8/1989 Gillard et al. 358/105
4,864,398 9/1989 Avis et al. 358/105
4,992,869 2/1991 Samad et al. 358/105
4,992,870 2/1991 Samad 358/105
5,005,077 4/1991 Samad et al. 358/105
5,025,495 6/1991 Avis 358/105

FOREIGN PATENT DOCUMENTS

2231749 11/1990 United Kingdom .
2231750 11/1990 United Kingdom .

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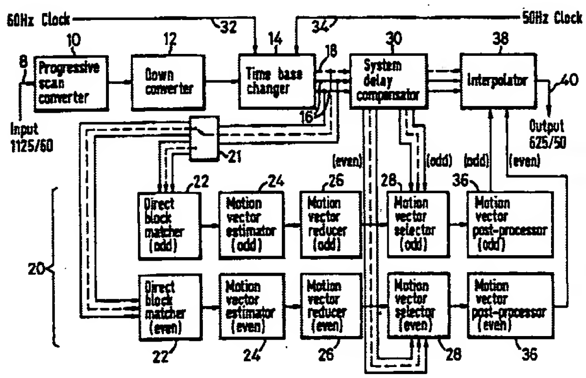
[57] ABSTRACT

A motion compensation image processing apparatus and method for generating motion vectors that represent image motion between a pair of input images from which an output image is derived by motion compensated interpolation. A plurality of motion vectors are generated for each pixel of the output image and it is determined whether respective test blocks of each of the pair of input images, pointed to by each of the plurality of motion vectors, lie partially outside their respective input images. If one or both of the test blocks lies partially outside its respective input image, the degree of correlation between the test blocks is detected by performing a first correlation test on parts of the test blocks lying inside their respective input images. However, if both of the test blocks lie wholly inside their respective input image, the degree of correlation between the test blocks is detected by performing a second correlation test. The motion vector having the highest degree of correlation between the test blocks is selected for motion compensation interpolation.

10 Claims, 11 Drawing Sheets



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US-PAT-NO: 5363146

DOCUMENT-IDENTIFIER: US 5363146 A

TITLE: Motion compensated image processing

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Detailed Description Text - DETX (15):

The pixel address generated by the address shifter 66 is then passed from the position detector 68 to the respective picture segment store 60, which supplies as an output a block of 5.times.5 pixels centred on the pixel pointed to by the motion vector under test. In this embodiment these blocks are supplied in full whether or not one or more rows or columns of pixels in the blocks lay outside the respective input image. The two blocks of pixels from the respective picture segment stores 60 are supplied to a block marcher 74 for further processing. In the block marcher 74 the luminance values of pixels at corresponding positions in the two blocks of pixels are compared and an array of absolute difference values, one value for each pixel position in the block, is generated and passed to a masker 76.

EAST Browser - L2: (9) 1 near5 mask$ | US 5574511 A | Tag: S | Doc: 6/9 (SORTED) | Format : KWIC

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Similarly, the terms foreground illumination and foreground lighting refer to the foreground or subject of an image being illuminated by one or more active light sources typically directed by baffles in addition to any ambient illumination. The background is not illuminated by the active foreground lighting. The terms front lighting or front illumination refer to the case where one or more active light sources are positioned near the optical axis of the imaging device to illuminate the subject of the image. The line of demarcation is defined as the line of pixels that separates the foreground and background regions of a digital image. Two digital imaging devices have the same virtual spatial location when the images taken by the devices are identical. A digital imaging device includes any device which uses a CCD (charge-coupled device) such as, but not limited to, an electronic camera or a camcorder.

In the present invention, an original background of a digitally captured image is replaced with a predetermined replacement background by comparing lighting characteristics between pixels of the image. One of the lighting characteristics that can be considered is light intensity. Another is the contrast ratio, defined as the ratio of intensity values of pixels at the same, i.e. corresponding, location that are compared between two images of the same scene taken at the same time.

COMPARISON

Illuminating the background and foreground regions of the image with lights of different intensities, i.e. different illumination patterns, provides a useful mode of comparison. A comparison of all pixels in the image provides information which can be analyzed to delineate the foreground and background regions of the image. However, several problems do exist.

Measurement of light intensity is directly related to the reflectance of an object from which the light is being measured. For instance, if an object is illuminated with light and exhibits a high reflectance, then most of the light incident to the object is reflected and available for measurement. However, a problem occurs if the object being illuminated has a low reflectance, since only a small amount of the light incident to the object is reflected and available for measurement.

In the present invention, the subject of the image is generally a person. Thus, the hairline of the subject will generally follow the line of demarcation separating the foreground and background regions of the image. It is known that blonde hair exhibits high reflectance and black hair exhibits low reflectance to visible light. Thus when a person having black hair is the subject of an image, the intensity of the reflected visible light incident to the black hair will be small, difficult to measure, and unacceptable for intensity comparisons. On the other hand, light in the IR region of the light spectrum exhibits high reflectance characteristics for both blonde and black hair. Furthermore, the sensitivity of commercially available CCDs includes the near infrared range of approximately 700 to 1000 nanometers. Thus, active light sources in the near infrared range are preferred for intensity comparisons according to the present invention.

The present invention allows an image to be taken regardless of the background of the scene. Thus, a photobooth or backdrop behind the subject is not required. However, a careful analysis of both the active and ambient lighting is in order. For the purposes of the current invention, a scene can be dissected into three regions; a foreground region, a near background region and a far background region. The foreground region includes objects near the imaging device which are the subject of the image, often a person. The near background region is the part of the background which can be affected by an active light source. The far background region is the part of the background which can not be affected by an active light source. For two IR images with different illumination patterns, a comparison of light intensity of pixels at each of the above three regions under varied lighting conditions will provide information necessary for creating a mask for separating the foreground and background regions of an image of the scene. In other words, the contrast ratios of intensity values of pixels at corresponding locations of the two IR images will vary between the foreground and background regions.

Two IR images are taken of the same scene under different lighting conditions. The first is a front IR image IR_{FR} illuminated with front infrared radiation as shown in FIG. 2. The second is a background IR image IR_{BG} illuminated with background infrared illumination as shown in FIG. 3. Each image includes a foreground 122 and a background 200 which is further broken down into a near background region 202 having objects which are effected by active light sources, and a far background region 204 having objects which are not effected by active light sources.

FIG. 2 shows the front illuminated IR image IR_{FR} taken with front IR lighting. Of course, ambient (i.e. non-active) IR foreground and background lighting will also be present in some amount for illuminating both the (foreground 202) and the background 200. Only ambient IR light having intensity "A" is reflected at various pixels in the far background since the front IR lighting is incapable of affecting the lighting of the far background. For instance, if the scene is a person standing in a lobby of a large building with a back wall 75 feet away, then the active IR lighting, i.e. the front IR lighting, will not illuminate the far background of the back wall. The front IR light, in combination with the ambient IR light, is capable of illuminating objects in the foreground 122 and the near background 202 at a light intensity "B" which is greater then the ambient IR light intensity "A".

FIG. 3 shows a background illuminated IR image IR_{BG} taken with no active front IR illumination (i.e. only ambient IR lighting is present in the foreground 122) and one or more background IR lights which have been activated to illuminate, in combination with any ambient IR lighting, objects in the near background region 202 of the background 200. Ambient IR light is reflected from pixels in the foreground and far background regions having an intensity of "A", and the background IR lighting combined with the ambient IR lighting is reflected from pixels in the near background region having an intensity of "C" which is greater than the intensity "B" of the front lighting in FIG. 2. For this preferred method, the intensity of the background lighting is greater than the intensity of the front lighting so that the relationships detailed in the following Table I will hold true.

The images IR_{FR} and IR_{BG} are preferably taken with the same IR imaging device in near temporal proximity, limited only by the shutter speed of the IR imaging device and the time necessary to switch the active IR lighting. By taking the two IR images as close together as possible in time, problems created by the movement of the subject or of objects in the near background can be avoided. More specifically, as long as the movement of the line of demarcation between the exposures is not detectable by the human eye, then the movement of the subject is negligible. Typically, a maximum time differential between exposures of about 1/30th of a second (i.e. the shutter speed of an electronic camera) will ensure negligible movement of the subject. Of course, if the

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to a visible light image of the scene and the preselected background is used to replace the original background.

Brief Summary Text - BSTX (9):
The present invention is useful in taking images for identification and other purposes without the requirement of a photobooth, regardless of the background of the image. The original background of the image is replaced with a preselected background. Two IR images with different intensities of IR illumination in the foreground and background regions of the scene, respectively, are compared for light intensity differences between corresponding pixels of the two images to form a mask differentiating between the foreground and background regions of the image. The mask is then applied to a visible light image of the scene and the preselected background is used to replace the original background.

Start 1:59 PM

TABLE II

Foreground pixel	$IR_{fg}(i,j) > IR_{bg}(i,j)$
Background pixel	$IR_{fg}(i,j) \le IR_{bg}(i,j)$

Thus, if a given pixel in IR_{fg} has a greater intensity at the same pixel location in IR_{bg}, then that pixel is identified in the mask as a foreground pixel; and if a given pixel in IR_{fg} has the same or lesser intensity at the same pixel location in IR_{bg}, then that pixel is identified in the mask as a background pixel.

The imaging devices 106 and 108 preferably are one color CCD type and one black and white CCD type (although two color CCD types are acceptable) with a good quality television lens of a desired focal length and filtered to restrict the spectral sensitivity to a desired spectral band. Compatible color video cameras 106 and 108 are preferred whereby one of the cameras is modified with an IR pass, visible reject filter to be able to record an IR image. All of the variables for taking a photograph such as the depth of field, focal length, etc. are easily established as necessary by one of ordinary skill in imaging science.

In an experimental setup used for testing the invention at Polaroid's Imaging Science Laboratory, a single imaging device was used for taking both the IR and visible light images of a mannequin. The imaging device consisted of a Philips CM800 black & white NTSC format (640×480 pixels) CCD camera with color separations made using wratten 25 (red), 58 (green) and 47B (blue) filters. Red, green and blue images were individually recorded during testing. Color balance was adjusted using wrattan neutral density filters and/or changing the lamp voltage for the three color filter exposures. The camera included a Computar f/1.4 16 mm FL lens with a 1 mm BG18 glass filter for IR rejection and a wratten 87B gel filter for visible light rejection. Digitization was accomplished using a Data Translation DT55-LC frame grabber with 7 bits of quantization.

Different size apertures can be used in the visible and infrared cameras, since the warping step will correct any misalignments between the visible and IR images. However, the best system includes visible and infrared cameras having the same size apertures. The infrared camera preferably should have a large aperture so that the background in the infrared images will be blurred. To the extreme, the background will appear uniform for both infrared images, but brighter when the background is illuminated. The influx of light can be controlled by using a transparency with an appropriate transmission rate. Most importantly, the infrared camera used should respond sensitively to small light intensity changes when the light is weak.

The foreground illumination for both the visible and near IR ranges in the test system was provided by three tungsten halogen Lowell Pro-Lights, model P1-10 (125 watts, 3200K @ 120 volts) which were each placed between 1 and 2 feet from the optical axis of the camera 200 and approximately 2.5 feet from the subject. Exposure was controlled by changing the lamp voltage. The background illumination for the appropriate IR image record was provided by three tungsten halogen Lowell Tota-Lights, model T1-10 (500 watts, 3200K @ 120 volts) with barn doors excluding the background lighting from behind the subject.

Mask Generation

Mask generation is a crucial task in background replacement. For the inventive background replacement method, a mask is generated for accurately distinguishing between the foreground and the background of an image. In one pre-

ferred embodiment, the foreground of the image is a person having his picture taken for identification purposes and the background is everything else in the image.

The basic mask generation method as claimed is outlined in the block diagram of FIG. 4. Assume that the front illuminated IR image $IR_f(i,j)$, the background illuminated IR image $IR_b(i,j)$, the visible light image $V_m(i,j)$ and the predetermined replacement background $B(i,j)$ have all been determined as described in the above sections, where i and j are integers which represent the horizontal and vertical coordinates of the images, respectively. A foreground pixel has the property $IR_f(i,j)>IR_b(i,j)$ and a background pixel has the property of either $IR_f(i,j)=IR_b(i,j)$ or $IR_f(i,j)<IR_b(i,j)$ depending upon whether or not the pixel is illuminated by active lights. In a typical system, each pixel of $IR_f(i,j)$ and $IR_b(i,j)$ is represented as $0 \le IR_f(i,j) \le 255$ or $0 \le IR_b(i,j) \le 255$, respectively. Subtracting $IR_b(i,j)$ from $IR_f(i,j)$ in step 400 yields a difference image DIFF(i,j) where each pixel is represented as $-255 \le DIFF(i,j) \le +255$. A sample 8×8 point difference image DIFF(i,j) for i,j=0,1 . . . 7 is shown below.

DIFF(i,j)

0	0	0	-1	1	0	-1	1
0	15	17	0	1	0	1	1
6	-2	-4	-1	0	0	1	1
-1	0	0	0	0	1	1	1
8	0	5	10	13	6	3	2
1	-4	27	250	212	11	5	4
-1	6	33	30	19	12	0	10
-2	1	15	22	160	15	0	0

DIFF(i,j) is binarized in step 410 to form a binarized image $M_s(i,j)$ by comparing the numerical value of each pixel of DIFF to a predetermined threshold value θ, then setting all pixel values which are greater than θ to a logic high and all pixel values which are less than or equal to θ to a logic low. This type of pixel classification is mathematically written as:

$$M_s(i,j)=1, \text{ if } DIFF(i,j)>\theta, \text{ or} \quad (1)$$

$$M_s(i,j)=0, \text{ otherwise},$$

where θ is a predetermined parameter which will be discussed in further detail hereinafter in conjunction with calculations for the modulation function of step 430.

The following 8×8 binarized image $M_s(i,j)$ of the above difference image DIFF is illustrative for i,j=0,1 . . . 7 when θ=5.

M_s (for θ = 5)

0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	0	1	1	1	0	0
0	0	1	1	1	1	0	0
0	1	1	1	1	1	0	1
0	0	1	1	1	1	0	0

Note that a change in θ can cause a significant change in the appearance and values of the binarized image $M_s(i,j)$. Contrast the above binarized image for θ=5 with the following binarized image for θ=10.

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DOCUMENT-IDENTIFIER: US 5923380 A

TITLE: Method for replacing the background of an image

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Brief Summary Text - BSTX (6):

The parent case to this application discloses the general approach for replacing the background of an image by differentiating between two infrared (IR) light illuminated images to distinguish between the foreground and background of the corresponding visible light image. It specifically discloses a background replacement method where two IR images with different intensities of IR illumination in the foreground and background regions of the scene, respectively, are compared for light intensity differences between corresponding pixels of the two images to form a mask differentiating between the foreground and background regions of the image. The mask is then applied to a visible light image of the scene and the original background is replaced with a preselected background.